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ON THE FAUNA OF THE LOWER COAL MEASURES OF CENTRAL IOWA.

BY CHARLES R. KEYES.

The carboniferous rocks of the region in the immediate vicinity of Des Moines have, until quite lately, yielded only fragmentary remains of fossils. Recent investigations, however, have disclosed a rich fauna embracing, as hereafter enumerated, more than 35 genera and nearly 60 species, the majority of them in a most perfect state of preservation. In Iowa the lower coal measures present, lithologically, a marked contrast with both the under-(subcarboniferous) and the over-lying (middle and upper coal measures) strata which are pre-eminently calcareous, while the lower coal measures are characterized by an almost total absence of the calcareous divisions, which are represented only by a few thin bands of impure limestone, local in distribution. A section of the rocks at Des Moines presents:

Drift	20	feet.
Löss	15	"
Middle coal measures	40	"
Lower coal measures	160	"

St. Louis limestone (not exposed in Polk county.)

The superficial deposits have been quite thoroughly studied by McGee and Call,[1] but the palæozoic rocks have in Polk county received but a passing notice. Though economically of far greater importance than any other formation in the state, the lower coal measures have received comparatively little geologic attention; and the two attempts at an exhaustive and detailed survey of this formation in Iowa, and a correlation of the different coal horizons was unfortunately rendered abortive by circumstances entirely beyond the control of those engaged in the study of the Des Moines valley region. In Iowa the lower coal measures probably have a maximum thickness of more than two hundred feet, but notwithstanding the fact that at Des Moines the entire formation underlies the city, which is situated just at the eastern border of the middle coal measures, this maximum is nowhere, in Polk county, attained. The base of the middle coal measures as characterized by Mr. St. John[2] and as is clearly shown in several localities in the immediate vicinity of Des Moines, is composed of variegated clays and shales, with one or two intercalated bands of impure nodular limestone. These variegated shales have a thickness of forty or more feet, and are easily recognizable at numerous exposures in the bluffs of the vicinity by the thin limestone bands, which within the city limits have yielded twenty or more species of fossils. There are also included in the middle coal measures some local depositions of micaceous sandstone, usually soft, and unfit even for the roughest masonry; some of it, however, is concretionary and quite durable. Formerly these portions were quarried for local use, but of late no attempt has been made for its utilization. At the southern extremity of Capital Hill this sandstone reaches a thickness of more than twenty-five feet. A short distance north of the city a sandstone having a thickness of twelve feet caps the bluff, and forms a high mural escarpment along the south side of the Des Moines river. Although the Des Moines and Racoon rivers have, in Polk county, corraded their channels through the upper strata, the lower coal measures are fully represented from the underlying St. Louis limestone[1]—the nearest exposure of which is about thirty miles below Des Moines—to the superimposing variegated shales just mentioned. This formation as represented in this vicinity is composed almost entirely of clays and shales, with a few thin layers of soft sandstone, and at least three workable beds of coal. The relative positions of the latter are shown in the following sections at the Giant Coal Mine where the fossil forms hereafter mentioned were chiefly collected:

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[1] *Vide* Am. Jour. Sci., vol. xxiv, Sept. 1882.

[2] White's Geol. Iowa, vol. I, p. 272.

Drift clay and carbonaceous shales	56	feet
Coal No. 1,	4	"
Shales, etc.	20½	"
Coal No. 2,	4½	"
Shales, lower layers fossiliferous.	35	"
Coal No. 3	4½ to 6	"

To the southwest, from Capital Hill, the distance between coals No. 2 and No. 3 appears to increase, and the latter vein attains a thickness in some places of seven feet. The coal measures of Iowa have a general dip to the south and west. To the northeast from Des Moines, the coal veins appear to thin out and finally are wanting, as shown in the accompanying sections; the first at Altoona, nine miles from Des Moines, and the second three miles north of Mitchellville, or sixteen miles from Des Moines.

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[1] *Vide* White on the Unconformability of the coal measures upon the older rocks, etc. Geology of Iowa, Vol. I, p. 225 *et seq.*

Drift and carbonaceous clays . . .	110 feet.
Shale	60 "
Sandstone	15 "
Coal	1½ "
Shale	15 "
Coal	4 "

A boring near Mitchellville at the eastern border of Polk county shows an almost entire absence of coal.

Drift	64 feet.
Blue and black shales with a thin band of limestone and one of sandstone . .	17½ "
Impure coal	1⅙ "
Gray, black, blue and sandy shales with two layers of sandstone	141½ "
Limestone, with marly partings . . .	39½ "

Coals No. 2 and especially No. 3, are the most profitably worked and furnish nearly all the coal mined in the county. Immediately overlying, and thus forming the roof of, coal No. 3 is a soft black clayey shale often slaty in places, highly fossiliferous and containing much iron pyrites in the form of crystals and nodules; many cubes of the former being over an inch along the edges, and the latter often containing shells of mollusca. The shell substance of the fossils from these shales, aside from those contained in the pyritiferous nodules, is replaced more or less completely by pyrite. In some specimens the replacement is complete; in others only a thin film of pyrite covers the shell, leaving the interior of the shell substance with the original calcareous constituents; between the two extremes all degrees of replacement by pyrite occur. In a few instances—*Lophophyllum*, fish-teeth and the remains of crinoids—no replacement has taken place. These fossiliferous shales are, upon exposure to the weather, easily and speedily disintegrated into a fine black clay, and the iron pyrite contained quickly decomposes; thus rendering it extremely difficult to obtain good specimens of fossils, unless the shales are examined immediately upon being taken from the mines. This fact may account, in part, for the apparent rarity of fossils from the lower coal measures of Central Iowa, as all traces of fossil remains are quickly obliterated after the shales have been disturbed.

Independent of its biological and geological relations, the fauna of the lower coal measures of Des Moines is of considerable interest in its bearing upon the geographical distribution during carboniferous times of certain species; and also on account of the close similarity in many respects, of this and the fauna of the lower coal measures of eastern Illinois, particularly that of the superimposing black shales of the "Danville" coal, or coal "No. 7" of the general Illinois section. Stratigraphically the relations of these two fossiliferous shales to the principal coal-beds are the same—each forming the roof of the most extensive coal stratum in their respective localities; lithologically the two shales are apparently identical.

CŒLENTERATA.

Lophophyllum proliferum McChesney.

Cyathaxonia prolifera McChesney, 1860. Disc. New Palæo. Fos. p. 60.

Cyathaxonia sp?. Geinitz, 1866. Carb. und Dyas in Nebraska, pp. 65, 66, tab. v, figs. 3–4.

Lophophyllum proliferum Meek, 1872. U. S. Geol. Surv. of Nebraska, p. 144.

This species though a characteristic, and usually one of the most abundant, fossils of the coal measures is extremely rare in the lower coal measures of central Iowa; however, it is not to be expected that the remains of cœlenterates would occur very abundantly in bituminous shales.

Rhombopora lepidodendroides Meek.

Rhombopora lepidodendroides Meek, 1872. U. S. Geol. Sur. of Nebraska, p. 144.

Rhombopora lepidodendroides White, 1875. Expl. and Sur. W. 100 merid. Vol. IV, pt. 1, p. 99.

From the lower coal measures but a single specimen of this species has been collected. In a thin band of limestone of the middle coal measures about one hundred feet higher than the horizon from which this specimen was found, this species occurs quite abundantly.

ECHINODERMATA.

Eupachycrinus (sp. ?).

The only remains of echinoderms as yet discovered in the black shales are a few stem joints and a brachial plate which evidently belong to one of the coal measure species of this genus.

BRYOZOA.

Synocladia biserialis Swallow.

Synocladia biserialis Swallow, 1858. Trans. St Louis Acad. Sci., Vol. I, p. 179.

Synocladia virgulacea Geinitz, 1866. Carb. und Dyas in Nebraska, p. 70.

The only bryozoan remains from the black shales consist of a few well preserved specimens of this species. From the investigations of Meek and Ethridge it would appear that Prout's genus *Setopora* is synonymous with *Synocladia,* and according to the former writer *S. cestriensis* from the Chester limestone is very closely allied to, if not identical with, *S. biserialis.* This would give *Synocladia biserialis* a much more extensive vertical range than has hitherto been supposed.

BRACHIOPODA.

Lingula umbonata Cox.

Lingula umbonata Cox, 1857. Geol. Surv. Ky., Vol. III, p. 576, pl. x, fig. 4.

Lingula umbonata White, 1884. 13 Ann. rep. Geol. Ind., pt. II, p. 120, pl. xxv, fig. 14.

The specimens from Des Moines are somewhat larger than the one originally figured by Cox (*loc. cit.*), and like that are broader posteriorly to the mid-length than anteriorly. The posterior margin is broadly rounded instead of being obtusely angular as it is often said to be, and as is shown in some figures of this species. None of the specimens under consideration are, therefore, so prominently subangular on the posterior margin, and broader anteriorly to the mid-length as those shown in the figures of Meek and Worthen[1] of a form which they call *L. mytiloides* Sowerby, while specimens of Sowerby's species figured by Ethridge[2] have the posterior margin even more sharply rounded or obtusely angular. No opportunity has been offered for directly comparing the American with the European forms and consequently their exact specific relations have not been sufficiently considered.

Discina nitida Phillips.

Orbicula nitida Phillips, 1836. Geol. Yorks., II, p. 221, pl. xi, figs. 10–13.

Discina nitida Meek and Worthen, 1873. Geol. Ill., Vol. V, p. 572, pl. xxv, fig. 1.

This species is common at the Polk county coal mine but has not as yet been discovered elsewhere in the county. The specimens collected are, on the average, smaller than those from other localities. Meek and Worthen regard *D. missouriensis* Shumard a synonym of this species.

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[1] Geol. Illinois, Vol. V, p. xxv, figs. 2a, 2b, 2c.

[2] Proc. Nat. His. Soc. Glasgow, Vol. IV, pl. v, fig. 3.

Productus nanus Meek and Worthen.

Productus nanus Meek and Worthen, 1860. Proc. Acad. Nat. Sci. Phila., p. 450.

Productus nanus Meek and Worthen, 1866. Geol. Ill., Vol. II, p. 320, pl. xxvi, figs. 4a, 4b, 4c, 4d.

This species was described from the lower coal measures of Jefferson county, and inasmuch as the St. Louis limestone is exposed in many of the creeks of that locality, its horizon is near the base of the coal measures; the horizon at Des Moines from which the specimens under consideration were obtained is somewhat higher. Though quite rare it will doubtless be found in other localities in the Des Moines valley. It is associated with *P. muricatus* N. and P. to which it presents differences that are both characteristic and constant. The almost total absence of spines in this species forms a marked contrast with the congeneric species of the same locality.

Productus cora D'Orbigny.

Productus cora d'Orbigny, 1842. Voyage dans l'Amerique Meridionale.

Productus pratterianus Norwood, 1854. Jour. Acad. Nat. Sci. Phila., Vol. III, p. 17.

Productus æquicostatus Shumard, 1855. Geol. Rep. Missouri, p. 201, pl. C, fig. 10.

Productus flemingi Geinitz, 1866. Carb. und Dyas in Nebraska, p. 52, tab. iv, figs. 1, 2, 3, 4.

Productus cora White, 1884. Ind. Geol. Rept. for 1883, p. 126, pl. xxvi, figs. 1, 2, 3.

A single specimen from the Polk County coal mine. This species was originally described from South America; but with the exception of Owen[1] and Marcou,[2] American paleontologists have until quite recently adopted for this form Norwood's name of *P. prattenianus*. A *Productus* collected from the Kinderhook in the vicinity of Burlington, and from the same horizon in Marshall county, unquestionably belongs to this species; if, however, this is the form described by White[3] as *P. lævicostus*, the latter is certainly synonymous with *P. cora;* the vertical range of which would extend downward to the base of the subcarboniferous.

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[1] Geol. Rep. Iowa, Wisconsin and Minnesota, 1852.

[2] Geology of North America, 1858.

[3] Boston Jour. Nat. His., Vol. VII, p. 230, 1860.

Productus muricatus Norwood and Pratten.

Productus muricatus Norwood and Pratten, 1854. Jour. Acad. Nat. Sci. Phila., Vol. III, p. 14, pl. i, fig. 8.

Productus muricatus White, 1875. Exp. and Sur. w. 100 merid. vol. IV, pt. I, p. 120, pl. viii, fig. 4.

In the geology of Yorkshire, (p. 214, pl. viii, fig. 3) Phillips in 1836 described *Producta muricata:* but the description is very brief and his figure would indicate that he had in hand a specimen of less than average size of *P. costatus* described by Sowerby nine years before. In Iowa, Dr. White found Norwood and Pratten's *P. muricatus,* most characteristic of the middle coal measures; the recent discoveries, however, show that it is the most abundant brachiopod of the lower coal measures in the region around Des Moines, yet the average size is somewhat less than that of the same species from the calcareous strata of the middle coal measures of the same locality. Both Davidson and Meek regard *P. muricatus* N. and P. identical with *P. longispinus* of Sowerby. Throughout Iowa at least, *P. muricatus* N. and P. presents characteristics that are remarkably constant; and when associated with *P. longispinus* no hesitancy whatever would be entertained in separating the two forms. The species of *Productus* described have been numerous, as is attested by an extensive and remarkable synonymy, which is only too apparent to those who have given the subject careful attention. The wide geographical distribution of some species, and the extensive vertical range of others, together with the concomitant differences of environment at the time when the species were living, readily accounts for the extreme variations presented. Inattention to this important factor has often led to the basis of species upon superficial characters which are relatively unimportant as classificatory criteria, and the confusion arising therefrom has rendered the study of this group extremely unsatisfactory.

Chonetes mesoloba Norwood and Pratten.

Chonetes mesoloba Norwood and Pratten, 1854. Jour. Acad. Nat. Sci. Phila., Vol. III, p. 27.

Chonetes mesoloba White, 1875. Expl. and Surveys w. 100 merid., Vol. IV, p. 123, pl. ix, fig. 7a.

This species is one of the most abundant of the brachiopods occurring in the bituminous shales of this locality. The average width of fifty specimens is nine millimeters, much below normal; specimens very much larger occur in other horizons. Here it is generally perfectly preserved in all its details; the mesial fold is more sharply defined, and the depressions on each side of the fold relatively deeper than is usual with this species. The depauperate condition of this, and in fact of all the brachiopods from the same horizon, is suggestive of an environment, at the time these animals lived, that was extremely unfavorable to the full development, and to the attainment of a normal size that would be rendered possible by a more congenial habitat.

Chonetes lævis nov. sp. (Plate XII, figs. 3a, 3b.)

Shell small; much wider than long; transversely semi-elliptical; the cardinal line as long as the greatest width of the shell, or often slightly extended beyond the lateral margins. Ventral valve convex, with no indication of a mesial sinus; beak not prominent; cardinal area rather narrow but well defined centrally, becoming linear toward the extremities; foramen moderately wide; cardinal margin bearing from four to seven oblique spines on each side of the beak. Dorsal valve flat or very slightly concave; with no mesial fold. Surface of both valves apparently perfectly smooth; but under a magnifier it is seen to be marked by numerous fine concentric striæ, and more prominent, often somewhat imbricated, lines of growth; these are sometimes crossed by fine nearly obsolete radiating striæ.

Length 7 mm.; breadth 12 mm.

This species is found in the superimposing black shales of coal No. 3 at Des Moines; and is associated with *Chonetes mesoloba*, *Productus muricatus*, and the minute gasterpods hereafter mentioned. The glabrate character, and the absence of a mesial fold and sinus, as is constant in all eight of the specimens found, forms a marked contrast with the associated congeneric forms, in which the radiating striæ are unusually sharp and well defined; and also with the other carboniferous forms of the same genus. This species is closely allied to, and perhaps identical with, the form described by Geinitz[1] as *Chonetes glabra*; but this name, however, was preoccupied by Hall in 1857, for a species from the Upper Helderburg.

Streptorhynchus crenistria Phillips.

Spirifera crenistria Phillips, 1836. Geol. Yorks., II, p. 216, pl. ix, fig. 6.

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[1] Carbonformation und Dyas in Nebraska, 1866, p. 60.

Orthisina crassa Meek and Hayden, 1858. Proc. Acad. Nat. Sci. Phila., p. 260.

Orthis robusta Hall, 1858. Geol. Iowa, vol. I, pt. II, p. 713.

Orthis lasallensis McChesney, 1860. New Palæo. Foss., p. 32.

Orthis richmondi McChesney, 1860. New Palæo. Foss., p. 32.

Hemipronites crassus Meek and Hayden, 1864. Palæ. Upper Missouri, p. 26.

Orthis crenistria Geinitz, 1866. Carb. und Dyas in Nebraska, p. 46.

Hemipronites crassus McChesney, 1867. Trans. Chicago Acad. Sci., p. 28.

Hemipronites crassus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 570.

At the Pioneer mine several moderately larger specimens have been obtained. This species has been more generally known as *Hemipronites crassus* M. and H. It is a common and characteristic fossil of the coal measures throughout Iowa and the contiguous states, and presents many varietal phases. Hall's *Orthis robusta* described from this state is unquestionably identical with this species. There is also associated with the Des Moines specimens a smaller form, about five millimeters in width, which appears to differ very materially from any forms of *S. crenistria* examined.

Spirifera camerata Morton.

Spirifer cameratus Morton, 1836. Am. Jour. Sci., vol. XXIX, p. 150.

Spirifer cameratus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 573.

Though a most abundant and characteristic species of the coal measures of the west, this species is represented in the Des Moines collections by only two specimens, one fairly good though somewhat crushed, and the other fragmentary, yet they exhibit distinctly the peculiar fasciculated costæ, as in the typical specimens.

Spirifera lineata Martin.

Spirifer lineatus Martin, 1809. Petrif. Derb. Coal Meas.

Spirifer perplexa McChesney, 1860. New Palæ. Foss.

Spirifera lineata White, 1884. Geol. Rep. Ind. for 1883, p. 133.

Pioneer mine; six or eight specimens were obtained, associated with *Athyris subtilita.*

Spirifera rockymontana Marcou.

Spirifer rockymontanus Marcou, 1858. Geol. N. A., p. 50.

Spirifer opimus Hall, 1858. Geol. Iowa, vol. I, pt. II, p. 711.

Spirifer subventricosus McChesney, 1860. Disc. New Palae. Fos. p. 44.

Pioneer mine: three specimens. This and *S. opimus* Hall are unquestionably synonymous; and though both names were proposed the same year, Marcou's has priority as has been shown by White (*Vide* under *Retzia mormoni*). McChesney in 1860 described this form as *Spirifer subventricosus,* but in the revision of his first paper he makes his species synonymous with Hall's *S. opimus.*

Spiriferina kentuckensis Shumard.

Spirifer kentuckensis Shumard, 1855. Geol. Sur. Missouri, p. 203.

Spiriferina kentuckensis Meek, 1872. U. S. Geol. Sur. Neb., p. 185.

Pioneer mine; two specimens. This species is quite common in the calcareous strata of the middle coal measures of the same locality.

Athyris subtilita Hall.

Terebratula subtilita Hall, 1852. Stans. Exp. Gt. Salt Lake, p. 409.

Athyris subtilita Newberry, 1861. Ives Exped. Colorado River, p. 126.

Not common; in fact, brachiopods are comparatively rare in the lower coal measures of the region under consideration, and with two exceptions the species are represented by few examples. In the limestones of the middle coal measures this species is quite abundant, and often attains a large size. As is well known it has a wide geographical and vertical distribution, being found from the Appalachian to the Rocky Mountain regions; it also occurs in the subcarboniferous of Europe and India. In all probability several species described from the subcarboniferous of this country will prove synonymous with this form. In North America its vertical range would then extend from the subcarboniferous through the coal measures into the permian.

Retzia mormoni Marcou.

Terebratula mormonii Marcou, 1858. Geology N. A., p. 51.

Retzia punctilifera Shumard, 1858. Trans. St. Louis Acad. Sci., vol. I, p. 220.

Retzia mormonii Meek and Hayden, 1859. Proc. Acad. Nat. Sci. Phila., p. 27.

This species is represented by two specimens, one of which is somewhat crushed. There appears to be satisfactory evidence that Marcou's name has priority. Dr. White says in a foot note on p. 125, volume IV, of Explorations and Surveys west of the 100th meridian :

" *Orthis pecosi*, *Retzia mormoni*, *Rhynchonella uta*, *R. rockymontana*, and *Spirifer rockymontana* were published by Marcou in his Geology of North America. I have obtained satisfactory evidence that the work was published as early as March 1, 1858. Vol. XV, of the Bulletin de la Société Géologique de France contains a statement that a copy of the book was sent to that society on April 20, 1858. In the same year Shumard and Swallow published a paper containing descriptions of the three first named species, under other names, in the transactions of the St. Louis Academy of Sciences, but that publication was not made until about the first of June. In December of the same year, Hall published in the Geological Report of Iowa, *Spirifera rockymontana* as *S. opimus;* and in 1860, McChesney published *R. rockymontana* as *R. etoniæformis.* It thus appears clear that Marcou is entitled to priority of all five of the names given above, as stated in the synonymy heading the descriptions of those species in this report."

LAMELLIBRANCHIATA.

Myalina swallovi McChesney.

Myalina swallovi McChesney, 1860. New. Palæ. Foss., p. 57.

Myalina swallovi Meek and Worthen, 1866. Geol. Ill., II, p. 341.

Giant mine : not common ; some of those obtained are in an excellent state of preservation.

Aviculopecten coxanus Meek and Worthen.

Aviculopecten coxanus Meek and Worthen, 1860. Proc. Acad. Nat. Sci. Phila., p. 453.

Aviculopecten coxanus Meek and Worthen, 1866. Geology Ill., vol. II, p. 326.

Of this little species six good specimens have been obtained at the Pioneer mine; none of them are larger than that figured by Meek and Worthen (loc. cit).

Aviculopecten neglectus Geinitz.

Pecten neglectus Geinitz, 1866. Carb. und Dyas in Nebraska, p. 33.

Aviculopecten neglectus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 589.

The specimens referred to this species are somewhat larger than either of those figured by Geinitz, or Meek and Worthen, but otherwise correspond in every particular. It is without ornamentation excepting concentric lines of growth and the folds or wrinkles of the ear.

Nuculana bellistriata Stevens.

Leda bellistriata Stevens, 1858. Am. Jour. Sci., 2nd series, vol. XXV, p. 261.

Nuculana bellistriata White, 1884. Geol. Rep. Ind. for 1883, p. 146.

At Des Moines this species is not common; but in the black shales overlying the workable coal seams at Van Meter in Dallas county it is very abundant, often being found in "nests" closely packed together.

Nucula parva McChesney.

Nucula parva McChesney, 1860. Disc. New Palæ. Foss., p. 54.

Nucula parva Meek and Worthen, 1873. Geol. Ill., vol. V, p. 589.

Giant mine; quite rare. Owing to its small size it might easily escape notice and this fact may partly account for the apparent rarity of this species.

Nucula ventricosa Hall.

Nucula ventricosa Hall, 1858. Geol. Iowa, vol. I, pt. ii, p. 716.

Nucula ventricosa White, 1884. Geol. Rep. Ind. for 1883, p. 146.

Many of the specimens collected exhibit the internal characters of the shell—the characteristic and well defined muscular impressions, and the small prominent teeth along the hinge line.

Schizodus (sp. und.)

This genus is represented by casts which occur in nodules of iron pyrites, but the specific characters have not as yet been made out.

Clinopistha radiata Hall.

Edmondia? radiata Hall, 1858. Geol. Iowa, vol. I, p. 716.

Clinopistha radiata Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 44.

Some of the Des Moines specimens exhibit no radiating striæ whatever, though the concentric lines of growth are often quite conspicuous. Inasmuch as the smooth forms and those having distinct radiating striæ, and between the two extremes every degree of gradation occur associated, it is questionable whether the variety *lœvis* M. and W. can be considered as having even the value of a variety; but is to be regarded rather as an individual and not a varietal difference.

Solenomya soleniformis Cox.

Solenomya soleniformis Cox, 1857. Geol. Sur. Kentucky, vol. III, p. 573.

At the Giant mine the form which is here referred to the species described in the Kentucky Geological report, vol. III, p. 573, is not common; it is considerably larger than that figured by Cox, but otherwise corresponds in all other observable particulars. It is by far the largest lamellibranch yet found at Des Moines, but the shell is very thin and easily detached from the matrix.

GASTEROPODA.

Dentalium meekianum Geinitz.

Dentalium meekianum Geinitz, 1866. Carb. und Dyas in Nebraska, p. 13.

Dentalium meekianum? Meek and Worthen, 1873. Geol. Ill., vol. V, p. 590.

This species is represented by numerous specimens, but none of them having both extremities perfectly preserved. The ornamentation in some of the specimens is well preserved, in others it is obsolete, and a few are perfectly glabrate.

Dentalium annulostriatum Meek and Worthen.

Dentalium? annulostriatum Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 45.

Dentalium? annulostriatum Meek and Worthen, 1873. Geol. Ill., vol. V, p. 589.

This species is represented by six specimens; in four of these the characteristic annular costæ are very prominent and the furrows separating the costæ are correspondingly quite deep.

Bellerophon percarinatus Conrad.

Bellerophon percarinatus Conrad, 1842. Jour. Acad. Nat. Sci. Phila., vol. VIII.

Bellerophon percarinatus Meek, 1872. U. S. Geol. Sur. Nebraska, p. 227.

Rather common and in a fine state of preservation. It is associated with the two other congeneric species here mentioned.

Bellerophon monfortianus Norwood and Pratten.

Bellerophon monfortianus Norwood and Pratten, 1855. Jour. Acad. Nat. Sci. Phila., vol. III, p. 74.

Bellerophon monfortianus Geinitz, 1866. Carb. und Dyas in Nebraska, p. 8.

Giant mine; a highly ornamented species, but not as common as its associated congeners.

Bellerophon urii Fleming.

Bellerophon urii Fleming, 1828 Brit. Anim., p. 338.

Bellerophon urii Keferst, 1834. Naturg. des Erdk., II, p. 430.

B. urii Phillips, 1836. Geol. Yorks., II, p. 31, pl. 17, figs. 11–12.

B. atlantoides d'Orbigny, 1840. Monog. des Céphalop. Cryptodibr., pl. 4, figs. 14–19.

B. urii Phillips, 1841, Palæ. Foss. Cornwall, etc., p. 106, pl. xl, fig. 199.

B. urii d'Arch. et de Vern, 1842. Geol. Trans., (2), vol. VI, pt. ii, p. 386.

B. urii Fleming et Portlock, 1843. Rep. on the Geol. of the County of Lond., p. 400, pl. XXIX, fig. 9.

B. d'Orbignyi Portlock, 1843. Rep. Geol. Lond., p. 401, pl. XXIX, fig. 12.

B. (*Euphemus*) *urii* McCoy, 1844. Syn. Carb. Fos. Ireland, p. 26.

B. urii de Koninck, 1844. Descriptions des Animaux Fossiles (de Belgique), p. 356, pl. XXX, fig. 4.

B. urii J. Morris, 1854. Cat. Brit. Fossils, p. 288.

B. urii Norwood and Pratten, 1854. Jour. Acad. Nat. Sci. Phila., vol. III, p. 75, pl. IX, fig. 6.

B. urii McCoy, 1855. Brit. Palæ. Foss., p. 555.

B. carbonarius Cox, 1857. Palæont. Rep. Ky. Geol. Sur., vol. III, p. 562.

B. blaneyanus McChesney, 1860. New Palæ. Foss., p. 60.

B. urii F. Römer, 1863. Zeitschr. d. d. geol. Ges., vol. XV, p. 582, taf. XV, f. 4.

B. carbonarius Geinitz, 1866. Carb. und Dyas in Nebraska, p. 6, tab. i, fig. 8.

B. blaneyanus McChesney, 1867. Trans. Chicago Acad. Sci., vol. I, p. 45, pl. ii, fig. 5.

B. urii Armstrong, 1871. Trans. Geol. Soc. Glasgow, vol. III, supp p. 61.

B. carbonarius Meek, 1872. U. S. Geol. Sur. Nebraska, p. 224, pl. iv, fig. 16; et pl. xi, fig. 11.

B. urii de Koninck, 1873. Recherches sur les Animaux Fossiles, p. 98, pl. iv, fig. 2.

B. carbonarius White, 1884. Geol. and Nat. His. Sur. Indiana, 13 rep., p. 158, pl. xxxiii, figs. 6, 7, 8.

Abundant at the Giant mine. The shell is of medium size; subglobose; dorsum broadly rounded. Umbilici closed. Aperture transversely semilunate, but not expanding more rapidly than the uniform increase in the size of the volutions; inner lip but slightly developed; outer lip thickened and rounded towards the umbilici, but becoming very attenuated towards the middle; its medial sinus rather broad, rounded and not very deep. Medial band obscure on the costate portion of the shell, but on the terminal half of the body whorl more or less distinct and in some specimens bordered on each side by a low, narrow, yet well defined, ridge. Surface except the last half of the outer whorl ornamented with from fifteen to thirty or more sharp, simple, nearly parallel costæ. Terminal half of body whorl smooth, except along the medial portion which is often marked by lines of growth, and sometimes by the low ridges, to which reference has already been made.

The form considered here under the name of *Bellerophon urii* is the one usually designated by American palæontologists as *B. carbonarius* Cox. A careful comparison of the descriptions and figures of the various writers on this group of Gasteropoda, and a large series of specimens fails to furnish any valid reason for separating specifically the American from the European form described by Fleming in 1828 as *Bellerophon urii.* Norwood and Pratten referred Cox's specimens to *B. urii;* but Cox in 1857 made it the type of a species which he called *B. carbonarius,* distinguishing it from the European form by the slight lateral expansion of the mouth and particularly by the less number of revolving costæ, which in *B. carbonarius* were said to vary from nineteen to twenty-five, while according to de Koninck *B. urii* had from thirty-six to thirty-eight. Though de Koninck does make this latter statement in his earlier[1] work, his later Recherches[2] state that the number varies from twenty-two to thirty. McChesney in the description of his *B. blaneyanus* seems also to have made the chief distinctive character between his species and the European form the possession by the former of only sixteen costæ, or about half the number ascribed to *B. urii* by de Koninck.

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[1] Descriptions des Animaux Fossiles, p. 356. (1844.)

[2] Recherches sur les Animaux Fossiles, p. 98. (1873).

Pleurotomaria brazoensis Shumard.

Pleurotomaria brazoensis Shumard, 1860. Trans. St. Louis Acad. Sci., vol. I, p. 624.

Pleurotomaria brazoensis ? Meek and Worthen, 1866. Geol. Ill., vol. II, p. 354.

The specimens of this species collected do not present much variation. The two peripheral carinæ are nearly equal and between them is located the concave band of the sinus. The whorls are ornamented by sixteen or seventeen strong filiform lines—nine below the lower carina, upon which there are two filiform lines; three above the upper carina upon which there are two and sometimes three lines; and a single line on the sinal band. Crossing the revolving lines are numerous prominent, equidistant transverse lines which give to the whole ornamentation a peculiarly yet regularly cancellated appearance; between, and parallel to, these transverse raised striæ are also from three to six microscopic, yet sharp and distinct raised striæ. Meek and Worthen refer with a query to Shumard's species a form from Macoupin county, Illinois, having about twenty-five revolving lines (twelve of which occupy the lower side of the body-whorl) instead of thirteen or fourteen as ascribed by Shumard to this species. Shumard says: "surface of volutions ornamented with from thirteen to fourteen rather strong filiform striæ which are crossed by sharp transverse striæ;" if by this he intends to convey the idea that this is the entire number of lines including those on the under side of the body whorl, Meek and Worthen remark that they "should scarcely entertain a doubt in regard to our [their] shell being a distinct species, since it uniformly has about double that number of revolving striæ on the last whorl." In this and some other groups of gasteropods much classificatory importance appears to have been attached to the number of revolving costæ; and sometimes a variation of three or four in the number has been almost the only basis for specific distinction. After a critical examination of a large series of different species presenting these characters, the question has arisen relative to the value of the number of costæ as a classificatory criterion. In some gasteropodous groups it has, within certain limits of course, small value; its exact importance in *Pleurotomaria* and some allied genera has not as yet been satisfactorily made out, but it is certain, however, that in some groups at least, it does not possess specifically such an important classificatory value as has been generally supposed.

Pleurotomaria modesta nov. sp. (Plate XII, figs. 2a, 2b.)

Shell small, sublenticular, spire greatly depressed, volutions six, obliquely flattened above; body whorl very large, rapidly increasing in size, sharply angular on the periphery, flattened or very slightly concave above, prominently rounded below, suture line linear; spiral band very narrow almost linear, very slightly impressed and occupying a position just above the peripheral angle ; on the spire the band is obscured by a single series of conspicuous nodes; aperture subquadrate, or subrhombic; umbilical region slightly impressed, but not perforated; surface glabrate; under a glass exhibiting fine lines of growth; the last whorl with a series of small transverse folds, or wrinkles, toward the tuberculated margin; each fold apparently originating at a node and extending about one-half or two-thirds the distance to the periphery.

Twenty or more specimens of this beautiful little species have been obtained from the black superimposing shales of coal No. 3. It approaches more closely than to any other the form described by Cox as *P. depressa* and may eventually prove identical with that form. *P. depressa*, however, was preoccupied by Phillips in 1836; and this name was also used by de Koninck and by Passy.

Pleurotomaria grayvillensis Norwood and Pratten.

Pleurotomaria grayvillensis Norwood and Pratten, 1855. Jour. Acad. Nat. Sci. Phila., vol. III, p. 75.

Pleurotomaria grayvillensis Geinitz, 1866. Carb. und Dyas in Nebraska, p. 9.

Shell rather small, conical subovate, longer than wide; spire moderately elevated; whorls five to seven, obliquely flattened above. Body whorl large, rapidly increasing in size, rounded below; biangular around the periphery, both angles being visible on the spire. Aperture subrhombic; outer margin sharp. Columella extended below. Surface ornamented by from twenty-five to forty revolving lines, of which twenty or more occupy the inferior surface of the body whorl; some of the lines are much more prominent than others, and there is a more or less regular alternation of the more prominent ones with less prominent raised striæ; these are crossed by numerous somewhat regular lines of growth, giving a more or less tuberculate appearance, which is most conspicuous toward the suture. The number of raised revolving lines appears to vary with the size of the specimens, and the maximum given is for the largest specimens collected. This species was originally described from Pasey county, Indiana, and Grayville, Illinois.

Pleurotomaria carbonaria Norwood and Pratten.

Pleurotomaria carbonaria Norwood and Pratten, 1855. Jour. Acad. Nat. Sci. Phila., (2), vol. III, p. 76.

This is by far the largest gasteropod yet discovered at Des Moines, and the test, as compared with that of the associated species, is extremely thick and heavy. A closely allied species has been described from the coal measures at Newport, Indiana, as *P. newportensis* White. According to Dr. White it differs from *P. carbonaria* in having "its revolving band ample and raised instead of concave, with revolving lines within it, as in that species; and also in having its aperture subcircular instead of semicircular."

Macrocheilus humilis, nov. sp. (Plate XII, fig. 1.)

Shell very small, short, subfusiform, or elongate-subovate; spire prominent, forming one-third or more of the entire length of the shell; volutions about six, increasing moderately in size, slightly convex. Test rather thin. Columellar fold distinctly visible within the aperture, which is subelliptical; callosity clearly defined but not conspicuous; outer lip thin, sharp. Suture well-defined but not deeply impressed. Surface smooth, but under a glass exhibiting lines of growth. Length 6 mm.; width 3·5 mm.

This little species is from the superimposing black shales of coal No. 3, at the Giant mine; and is found associated with the numerous other small gasteropods mentioned hereafter.

Macrocheilus gracilis Cox.

Macrocheilus gracilis Cox, 1857. Geol. Sur. Kentucky, vol. III, p. 570.

The roof shale of coal No. 3, has furnished a good series of this species, representing all stages of development up to those fifteen millimetres in length. The smaller specimens are less ventricose and have the spire proportionally higher than in the older ones, which approach nearer the form described as *M. ventricosus* Hall, and there is therefore reason to believe that the two species will eventually prove identical. Cox states in his description that his species was most likely a young shell. White[1] considers *Soleniscus*

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[1] Geol. Ind., Rep. for 1883, p. 155.

(*Macrocheilus*) *brevis* White, described in the supplement to vol. III, of the Expl. and Surv. west of the 100 merid. synonymous with *M. ventricosus* Hall.

Macrocheilus newberryi Stevens.

Loxonema newberryi Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 259.

Macrocheilus newberryi Hall, 1858. Geol. Iowa., vol. I, p. 719.

The specimens collected at Des Moines present considerable variation: some are typical *M. newberryi*, from which others gradate into forms more nearly approaching that described by Hall from Alpine Dam as *M. fusiformis*; hence their identity is not improbable. This is also in corroboration with the suggestion of Dr. White in the Indiana geological report for 1883 that "with full collections at hand, it will be difficult to clearly define the specific characters between *M. newberryi*, *M. planus* and *M. fusiformis*."

Orthonema conica Meek and Worthen.

Orthonema conica Meek and Worthen, 1866. Proc. Acad. Nat. Sci. Phila., p. 270.

Orthonema conica Meek and Worthen, 1873. Geology Ill., vol. V, p. 390.

This species is represented by only two specimens, both somewhat smaller than those figured by Meek and Worthen.

Actæonia minuta Stevens.

Loxonema minuta Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 260.

Actæonia minuta Meek and Worthen, 1873. Geol. Ill., vol. V, p. 594.

This is one of the most abundant of the small gasteropods occurring in the bituminous shales overlying coal No. 3.

Aclisina minuta Stevens.

Aclis minuta Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 259.

Common; associated with *A. robusta*, compared with which it is much more slender, and the spire possesses three or four more volutions.

Aclisina robusta Stevens.

Aclis robusta Stevens, 1858. Am. Jour. Sci., (2), vol. XXV, p. 259.

Aclis robusta Meek and Worthen, 1873. Geol. Ill., vol. V, p. 596.

Abundant. This and the preceding species were described by Stevens under *Aclis,* but in 1881 de Koninck established the genus *Aclisina* which now includes the four American carboniferous species originally described under the former genus.

Streptacis whitfieldi Meek.

Streptacis whitfieldi Meek, 1871. Proc. Acad. Nat. Sci. Phila., p. 173.

Streptacis whitfieldi Meek and Worthen, 1873. Geol. Ill., vol. V, p. 596.

This species is very rare, and is found associated with the four preceding species.

Anomphalus rotulus Meek and Worthen.

Anomphalus rotulus Meek and Worthen, 1866. Proc. Acad. Nat. Sci. Phila., p. 268.

Anomphalus rotulus Meek and Worthen, 1873. Geol. Ill., vol. V, p. 597.

One of the most abundant species occurring in superimposing shales of coal No. 3. In some of the specimens there is a tendency to become angular around the periphery toward the terminus of the body-whorl.

Euomphalus rugosus Hall.

Euomphalus rugosus Hall, 1858. Geol. Iowa, vol. I, p. 722.

Straparollus (*Euomphalus*) *subrugosus* Meek and Worthen, 1873. Geol. Ill., vol. V, p. 607.

Euomphalus rugosus White, 1884. 13th Rep. Geol. Indiana, p. 161.

This species is quite common.

Euomphalus pernodosus Meek and Worthen.

Straparollus (*Euomphalus*) *pernodosus* Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 45.

Straparollus (*Euomphalus*) *pernodosus* Meek and Worthen, 1873. Geol. Ill., vol. V, p. 604.

But a single specimen of this large *Euomphalus* has been found at Des Moines.

CEPHALOPODA.

Orthoceras rushensis McChesney.

Orthoceras rushensis McChesney, 1860. New Palæ. Fossils, p. 68.

Orthoceras rushensis White, 1884. Geol. Report Ind. for 1883, p. 164.

Specimens of this, and perhaps other species, often occur quite abundantly. The specific characters of the described species of this genus are so obscure that all attempts to separate many of the so-called species prove futile. A careful comparison of the carboniferous forms will doubtless lead to a considerable increase in the synonymy of this group, and a reduction of the number of species to four or five.

Orthoceras (sp. und.)

A single specimen from the Pioneer mine; it is nearly 50 cm. in length and has a diameter at the larger extremity of about 5 cm. It is by far the largest specimen of this genus yet observed in the carboniferous rocks of Iowa.

Nautilus lasallensis Meek and Worthen.

Nautilus lasallensis Meek and Worthen, 1866. Proc. Acad. Nat. Sci. Phila., p. 261.

Nautilus lasallensis Meek and Worthen, 1873. Geol. Ill., vol. V, p. 610.

Quite common at the Giant mine; but few of the specimens are in a very good state of preservation.

Nautilus occidentalis Swallow.

Nautilus occidentalis Swallow, 1858. Trans. St. Louis Acad. Sci., vol. I, p. 196.

Nautilus quadrangularis McChesney, 1860. Disc. New. Palæ. Foss., p. 65.

Nautilus nodocarinatus McChesney, 1860. Disc. New Palæ. Fos., p. 66.

Nautilus biserialis Hall, 1860. Geol. Iowa, Supp., p. 92.

Nautilus occidentalis McChesney, 1867. Trans. Chicago Acad. Sci., p. 57.

Only a single specimen has thus far been found at Des Moines.

Nautilus winslovi Meek and Worthen.

Nautilus (*Temnocheilus*) *winslovi* Meek and Worthen, 1870. Proc. Acad. Nat. Sci. Phila., p. 50.

Nautilus (*Temnocheilus*) *winslovi* Meek and Worthen, 1873. Geol. Ill., vol. V, p. 609.

Nautilus winslovi White, 1884. Geol. Ind., Rept. for 1883, p. 165.

Not common, and usually fragmentary.

CRUSTACEA.

Cythere nebracensis Geinitz. ?

Cythere nebracensis Geinitz, 1866. Carb. und Dyas in Nebraska, p. 2.

It is with some doubt that the form from Des Moines is referred to Geinitz's species; it is much smaller than that which he described, and also differs in other particulars. A dozen or more good specimens were collected at the Pioneer mine where they were associated with *Synocladia biserialis.* This and a trilobite are the only crustacean remains thus far discovered in the carboniferous strata at Des Moines. The remains of articulates in the lower coal measures of Iowa are exceedingly rare, and the only hitherto known specimens of this group are more or less fragmentary remains of a single genus of trilobites. Prior to this, ostracoid crustaceans have been collected in Iowa in the upper and middle coal measures, and now is recorded their presence in the strata of the lower coal measures of the state.

Phillipsia (sp. ?)

Of the trilobites only a single pygidium of a *Phillipsia* has been collected, and this at the Pioneer mine.

VERTEBRATA.

Petrodus occidentalis Newberry and Worthen.

Petrodus occidentalis Newberry and Worthen, 1866. Geol. Ill. vol. III, p. 70.

From the Pioneer mine have been collected nearly all the remains of fishes that have been found in the carboniferous strata of this region. It is with some little doubt that the dermal tubercles that are here referred to this species really belong to it. The base is subquadrate in outline; and the thin abruptly sharpened edge is broader than in the one figured by Newberry and Worthen; the ridges extending downward towards the obtuse angles of the base are much more prominent than the others, which do not extend to the top of the crown. There has also been collected at this mine the fin spines of two species; one about two centimeters, and the other four centimeters in length; the former is the more common and in a very perfect state of preservation.

Diplodus sp. ?

From the superimposing shales of coal No. 3 at the Giant mine. The specific characters of the teeth collected have not been satisfactorily made out. They are evidently not far removed from *D. amplicatus* M. and Worthen, but the denticles are larger, more slender and much longer than in that species.

Synoptical Table of Genera and Species.

		genera	species
Cœlenterata	Polypi	1	1
Echinodermata	Crinoidea	1	1
Vermes	Brachiopoda	9	14
	Bryozoa	1	1
Mollusca	Lamellibranchiata	7	9
	Gasteropoda	10	20
	Cephalopoda	2	5
Crustacea		2	2
Vertebrata		2	2

Summing up the predominant faunal features as presented in the accompanying synoptical table, it appears (1) that in those groups having an optimum habitat marine there was not only a fewness of species but also an extreme paucity of individuals; (2) that brachiopods though well represented in both genera and species were in fact not as proportionately abundant as might be expected when it is remembered that this type of life had now nearly reached its greatest expansion and culmination, and (3) that the fauna was predominately molluscan—nearly two-thirds of the entire number of species.

The Cœlenterata, Bryozoa and Echinodermata form indeed a very inconspicuous proportion of this local fauna, only three or four specifically distinguishable traces of each group being obtained. Though the Brachiopoda are represented by fourteen species, included in nine genera, they were with three exceptions of comparatively rare occurrence—*Productus muricatus*, *Chonetes mesoloba* and *Discina nitida* only being abundant. The brachiopods are also all depauperate, attesting conditions at the time that they lived extremely unfavorable to their full development and to the attainment of a normal size that under more congenial circumstances would have been rendered possible. Molluscan life, while the black shales forming the roof of coal No. 3 were being laid down, flourished luxuriantly, especially the gasteropods which in number of species composed more than one-third of the entire fauna. Not only did they exceed in species but they far outnumbered all others in individuals, and while as a rule they were small and some of them even minute their great numbers made up, in great part at least, for the conspicuity of larger but few forms. Though the majority of the forms of this group are small it is not a depauperation as among the brachiopods, as is shown by the average size of the individuals of each species being normal, and in some instances even considerably above. Some of the species are also of interest because of their recognition for the first time within the limits of the state, and thus to a considerable extent their known geographical range is increased. Others of the species enumerated are now known to have a wide geographical distribution which is suggestive of a somewhat extended vertical range. Among recent mollusca and especially land forms a wide geographical distribution, as has been remarked by Binney, appears to be indicative of a high antiquity for the group. The corroborative evidence is abundant: a notable instance is the living *Zonites,* four or more species of which are circumpolar in their distribution; and the genus—even a subgenus *Conulus* to which one of these living forms belongs—ranges back to the carboniferous, while the genus *Pupa* is represented in the carboniferous by four species. Cephalopods are not abundant in the region under consideration and are represented by only two genera and five species, yet a *Nautilus* attained a diameter of twenty centimetres, and an *Orthoceras* was fifty centimetres in length with a diameter at the larger extremity of five centimetres. Of the lamellibranchs the majority are small, though two of them are comparatively large, attaining a length of nearly ten centimetres, yet having an extremely thin and fragile shell. One of the specimens collected is of especial significance as exhibiting in all its details the internal features of the shell—the characteristic well-defined muscular scars and the edentulous hinge margin; in fact, so closely does it resemble in these characters, the general form and external appearance, a modern *Anodonta* that it is difficult to see how it can be generically separated from it; and should further investigation prove that the specimens under consideration really belong to that genus, it would be of unusual interest in its bearing upon the distribution of freshwater or non-marine mollusca during geologic times. The modern *Unio* and allied genera certainly have both a wide geographical and geological distribution, as is shown by the rich discoveries of *Union-*

idæ in the Mesozoic strata of the west: and the genus *Anodonta* is, if the opinion of Hall is adhered to, represented in the Devonian by two species, but that these two forms really belong to *Anodonta* is still questioned. Dawson has described several allied forms from the carboniferous of Nova Scotia; their family position is as yet also unsettled. With these considerations in view, the evidence thus far obtained points to a high antiquity for this group of bivalves which now is so abundantly represented in all our streams and ponds. As will be noted Crustaceans are represented by a species of *Cythere;* and a trilobite of which a single pygidium only has been discovered. Vertebrates are rare also, a few fish spines about two centimetres in length, and several teeth, and dermal tubercles are the only remains of this class found.